Connecting the Solar System and Extra-Solar Systems with SAFIR

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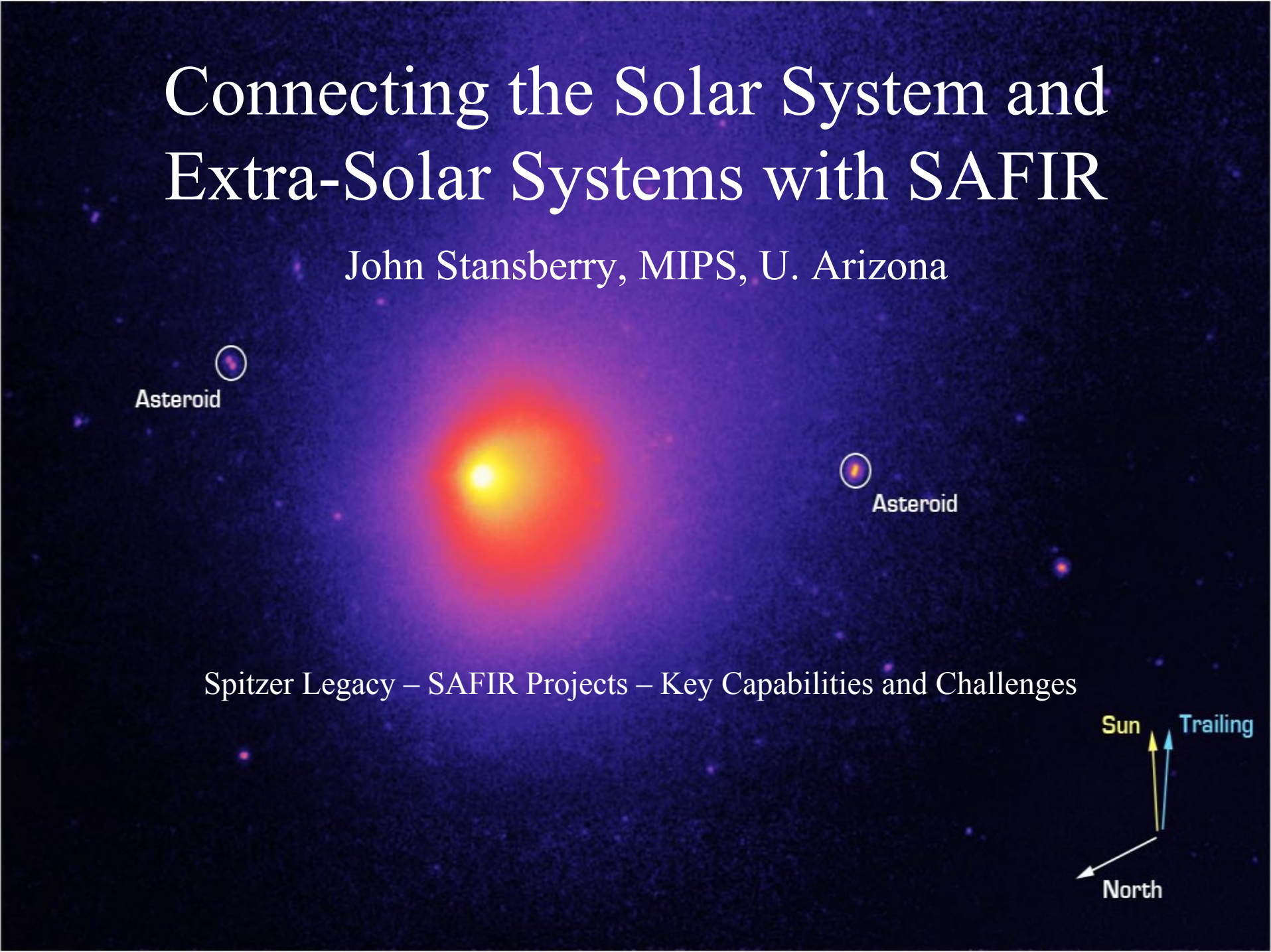


Spitzer Legacy – SAFIR Projects – Key Capabilities and Challenges

Science Goals

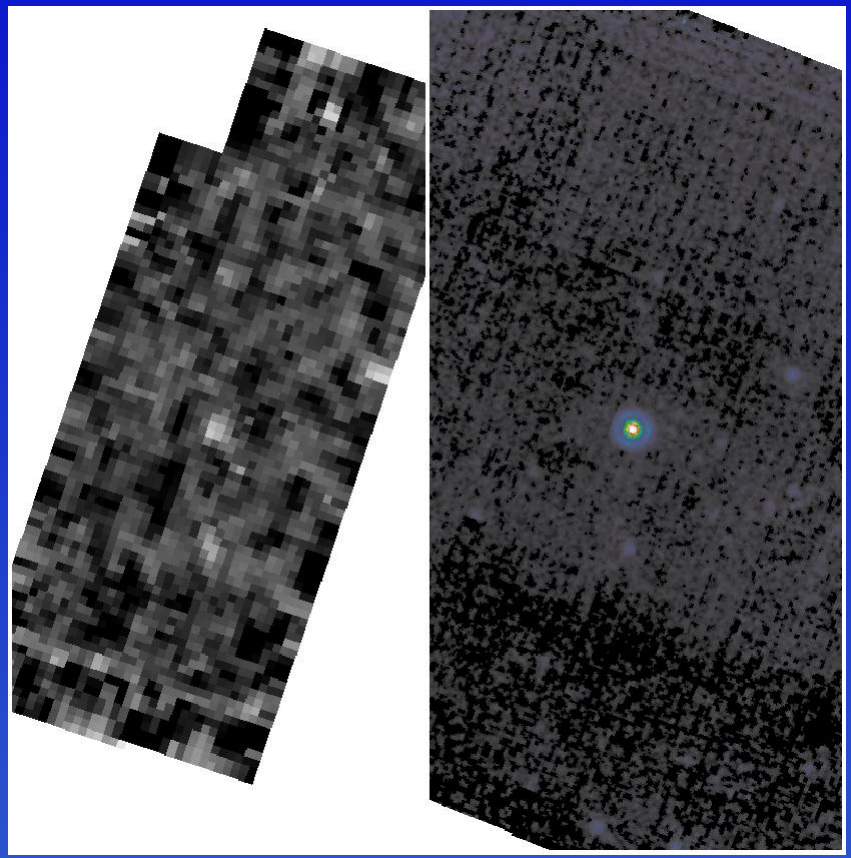
- Planetary
  - Origin and evolution
    - Chemical and isotopic composition
    - Similarities and differences w/ Solar, and other system members
  - Physical/chemical properties vs. class, location, …
    - Keys to processes
- Extra-Solar
  - Dust as indicator/tracer of planetary systems (debris)
  - Dust composition, distribution, mass
  - Direct studies of exoplanets
- Is the Solar system unusual or even unique?

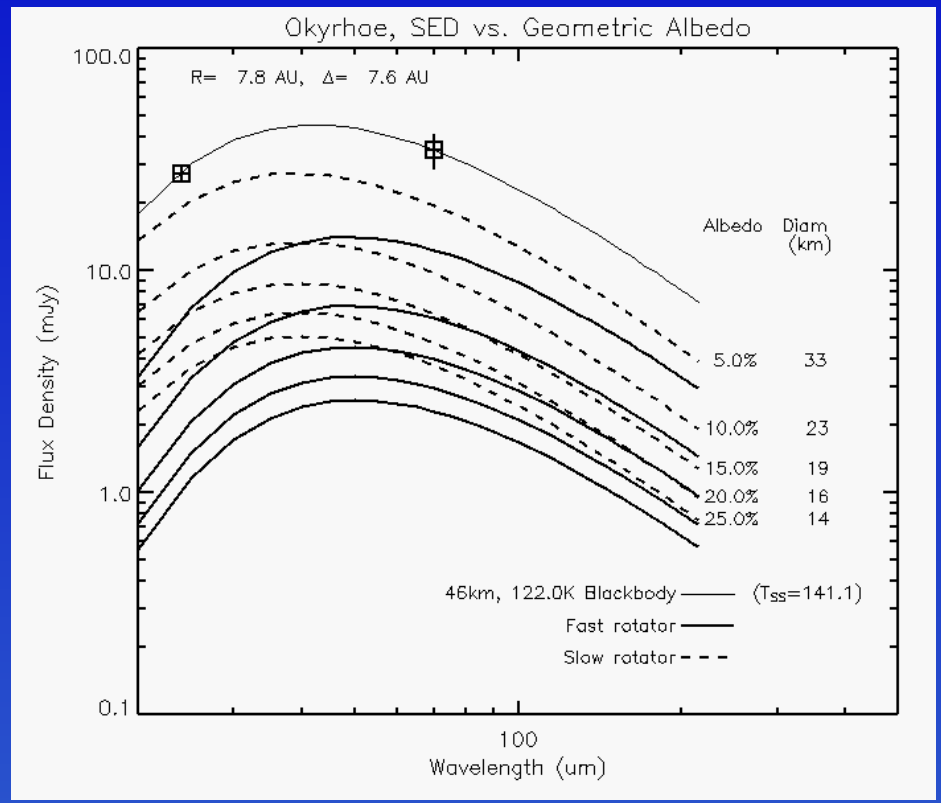
The Solar-System Legacy of Spitzer

- Spectra of Uranus, Neptune, Pluto
- Mid-IR albedos & spectra, and thermal properties of Pluto, Triton, many satellites
- Spectra of many current & extinct comets/comae, asteroids
- Albedos, diameters of ~10^3 asteroids, ~50 Centaurs, ~200 KBOs
- Zodiacal dust structures, composition (via comae), size
- New…
  - Species, dust components, classes

The Solar-System Legacy of Spitzer

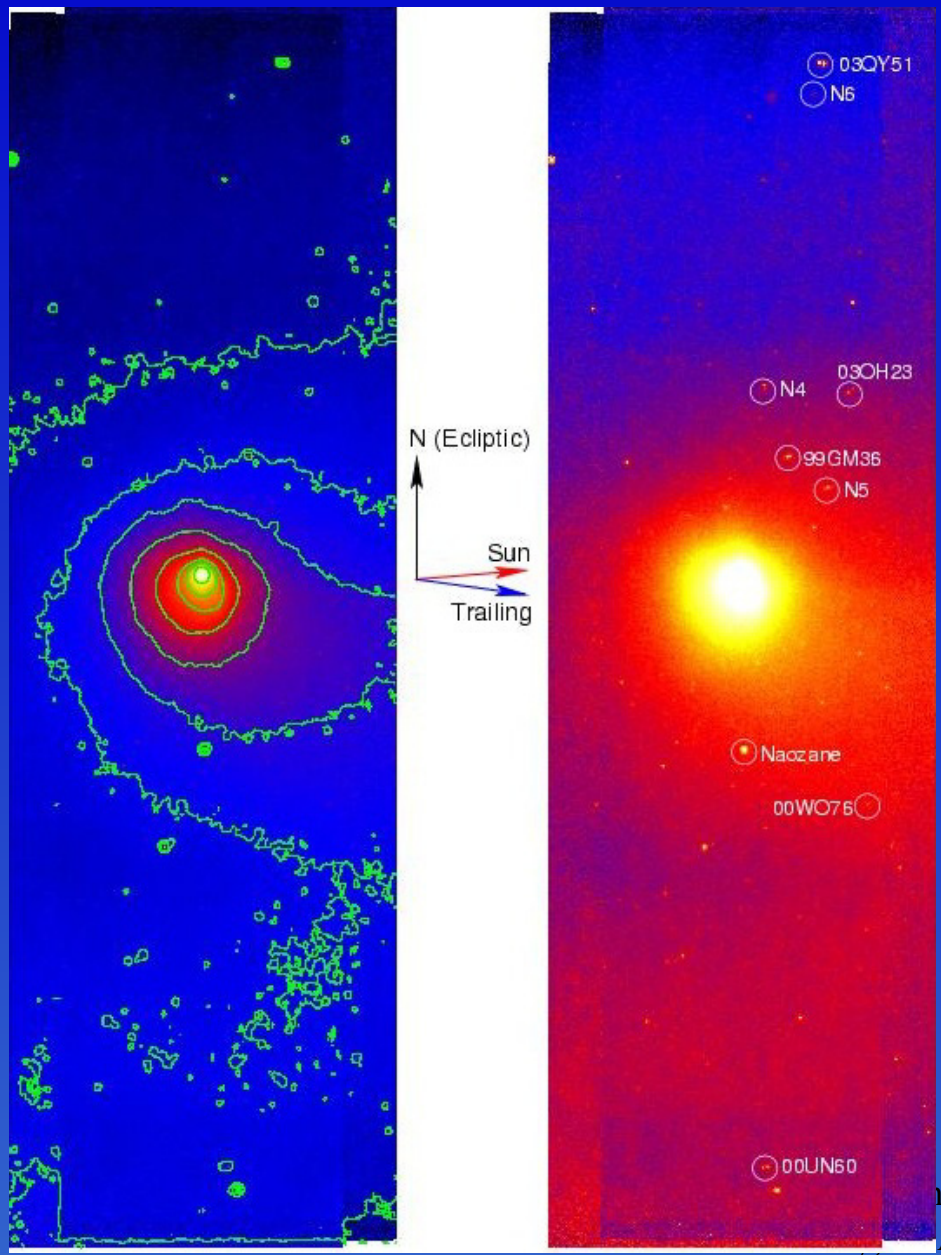
Albedos and Diameters of Primitive Bodies



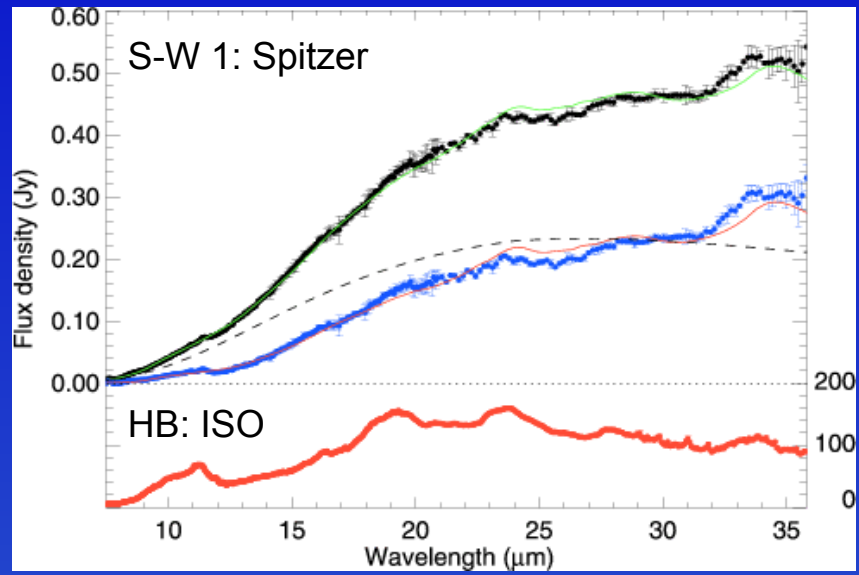


Cruikshank *et al.*, 2004

The Solar-System Legacy of Spitzer



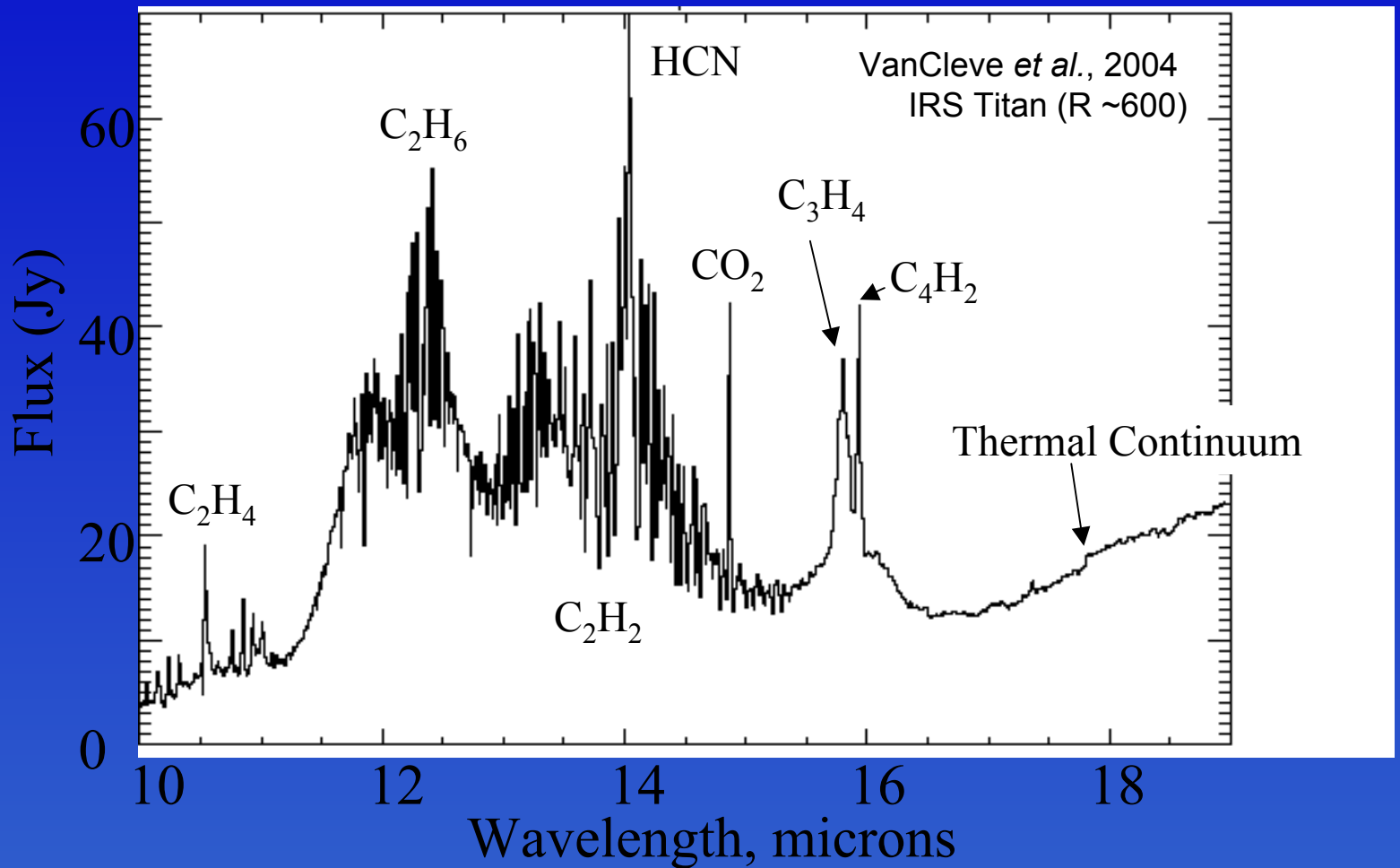
Cometary activity, dust composition.
Serendipitous asteroids.



29P/S-W 1, Stansberry *et al.*, 2004

The Solar-System Legacy of Spitzer

Composition, Structure of Planet and Satellite Atmospheres



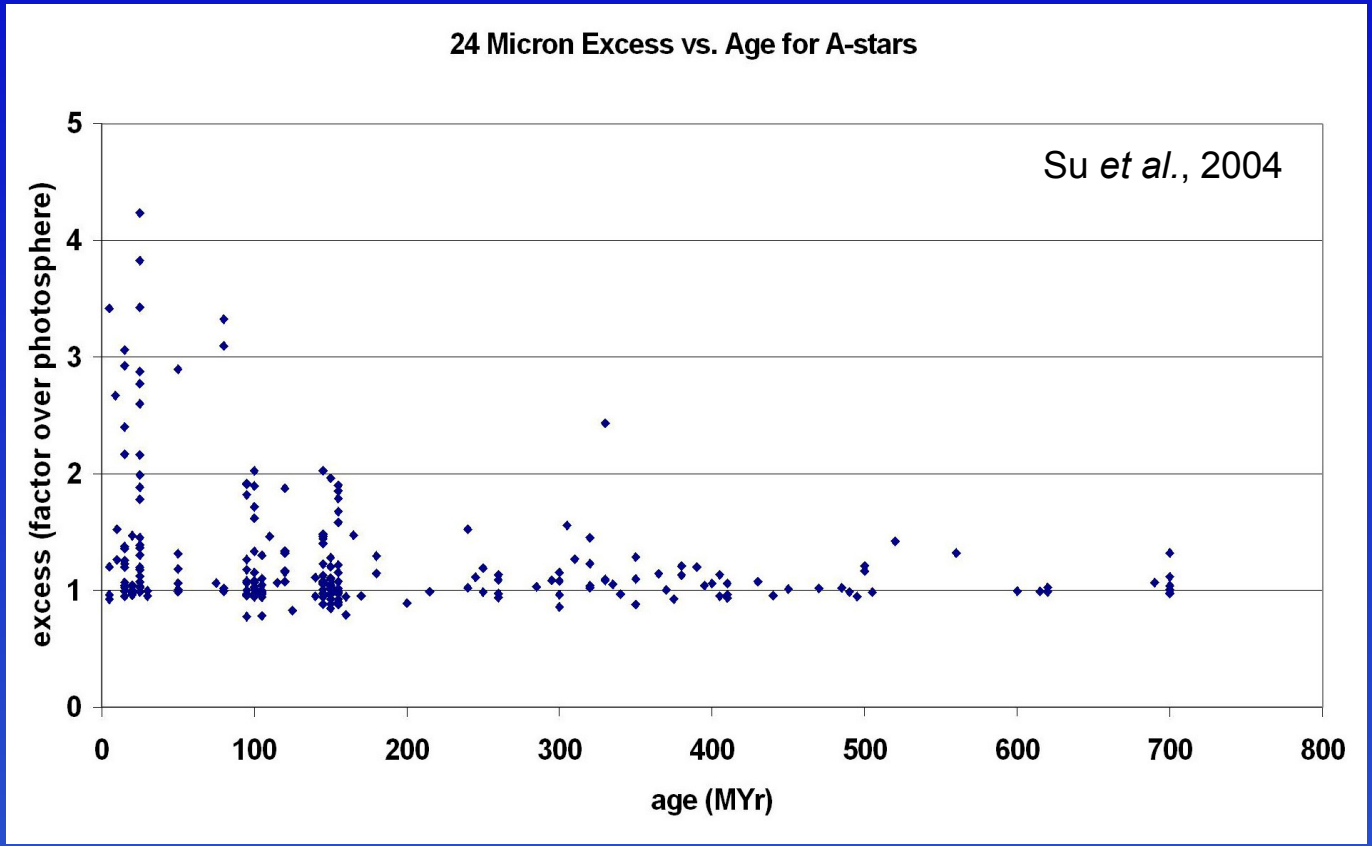
The Exo-System Legacy of Spitzer

- Many GTO, Legacy, GO disk programs
  - Age, associations, spectral type, metallicity, binarity, planets
  - ~10^3 systems, plus many young clusters
  - Resolved images of brightest debris disks
  - Gaps/clearings from SEDs
- Brown dwarf companions (IRAC)
  - ~20 AU and beyond
- Dust composition
  - Dependence on system parameters
  - Comparison w/ SS dust (comets)

The Exo-System Legacy of Spitzer

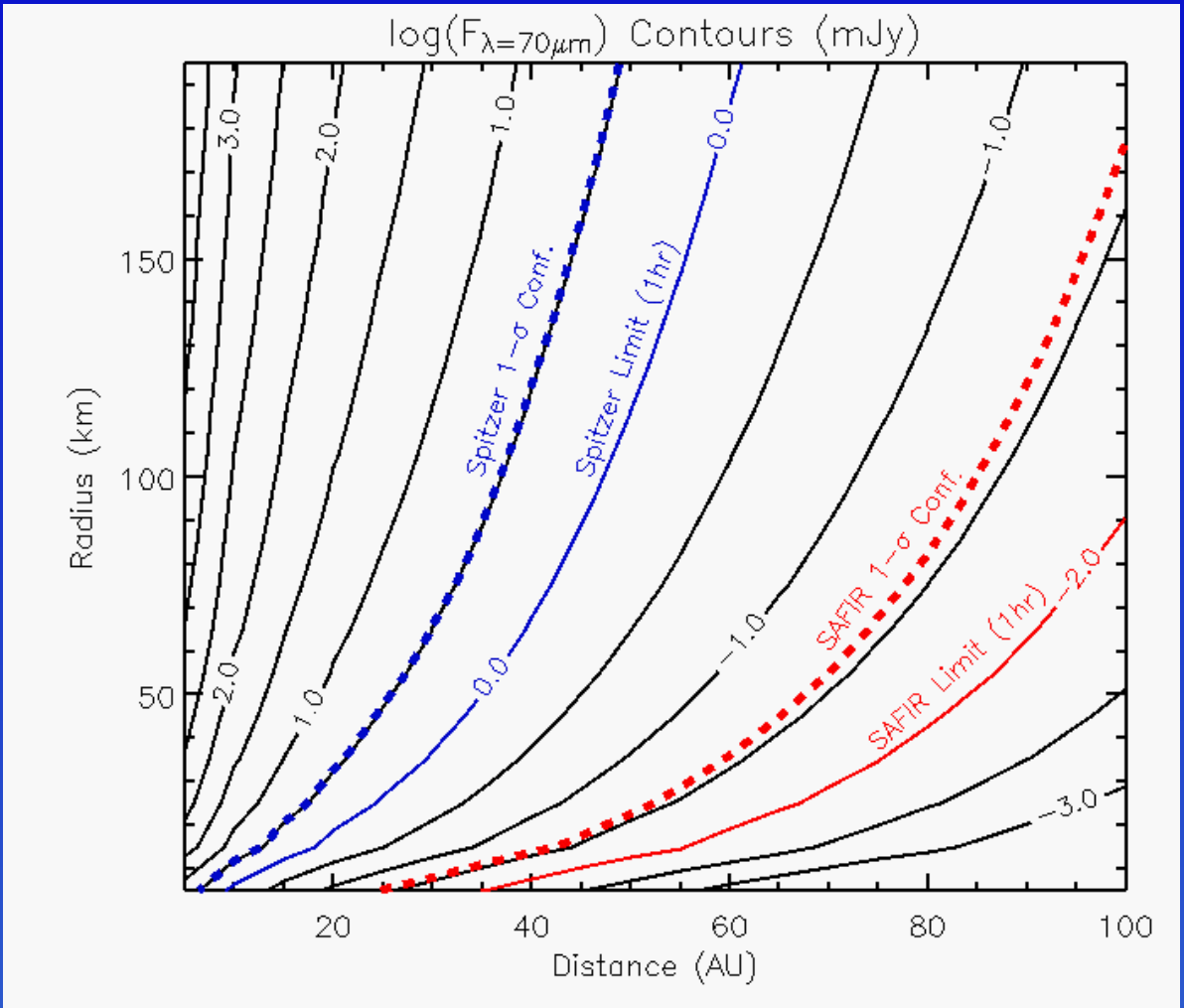
Evolution of disk mass with system age

- Non-Equilibrium
  - Unusual structures in disks
  - Time variable?
    - Magnitude
    - Brightness
- Systems w/o disks
  - Initial angular momentum
  - Metal-poor?



SAFIR: Kuiper-Belt Studies

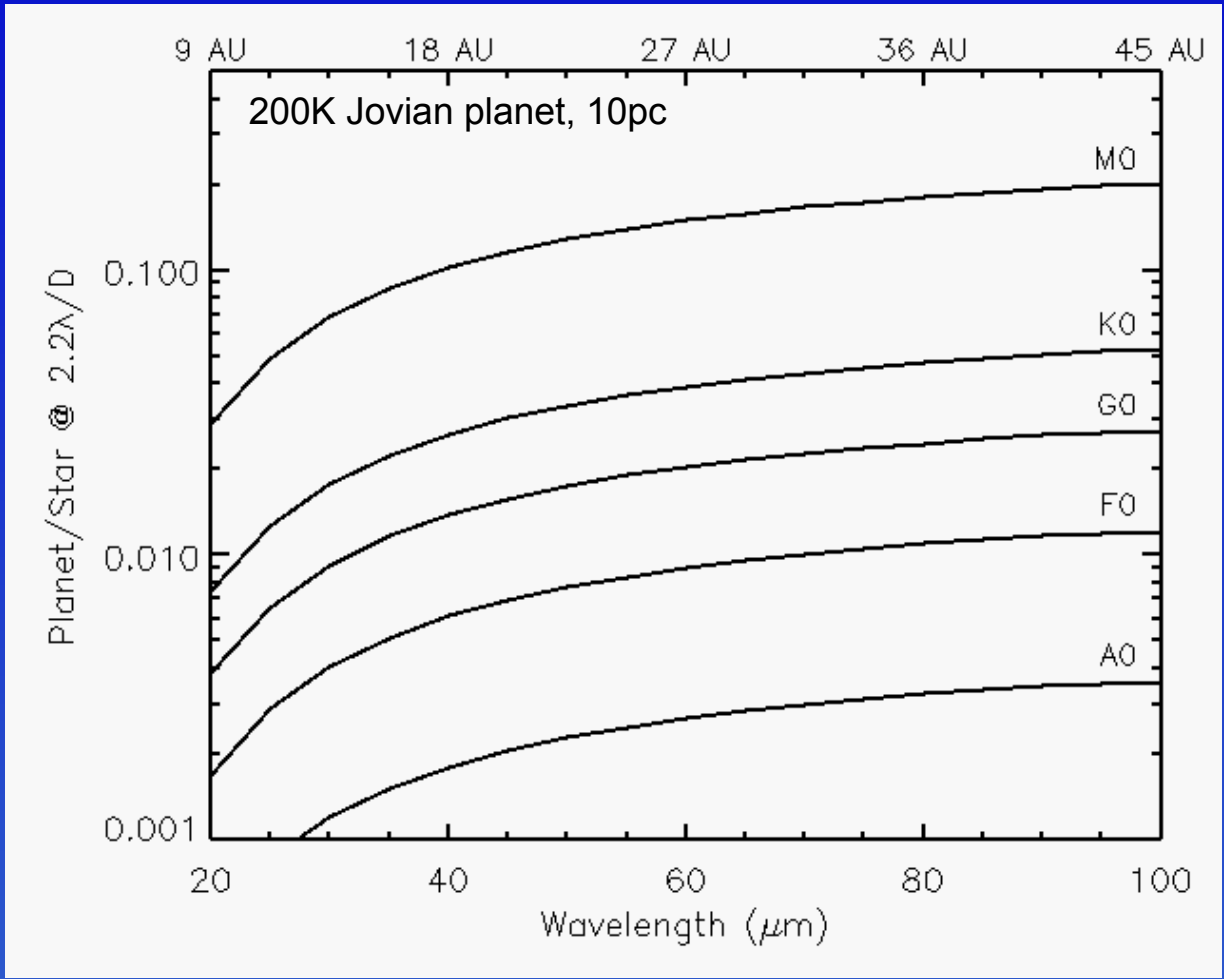
- 1e5 KBOs > 50 km radius
- Dynamical classes
  - Classical, scattered, resonant, Sedna, ?
  - Clues to orbital evolution of planets
- Extreme color diversity
- Source for P-Comets, Centaurs
- Analog for dust parent bodies in exo-disks
- Real compositional studies require knowledge of albedo



SAFIR: Exo-Systems Studies

Jovian Planets around nearby stars

- Roughly 500 stars w/in 10pc
- SAFIR could directly detect giant planets in these systems
- Planets around low-mass stars



SAFIR: Promise

- Sensitivity (~100x Spitzer)
  - Smaller, more distant, more numerous targets
  - Higher spectral resolution
- Spatial resolution
  - Satellites, planetary imaging, comet nuclei
  - Extra-solar dust structures and planets
- Spectral coverage
  - HD, xO, H_2O ice and gas, silcates

SAFIR: … and Challenge

- Sensitivity
  - Saturation
  - Asteroids
- Spatial resolution
  - Coverage: large arrays, scanning/mapping
- Spectral coverage
  - Rich, well studied 1-20um region not covered
  - Can this gap really be filled by other means?
  - Yet more lab data needed…

End

SAFIR: Exo-Systems Studies

- Brown Dwarfs could also be detected
- Probably not a unique discovery space (near- to mid-IR imaging better?)